Comparison of Myocardial Perfusion Scintigraphy and Coronary Angiography Results

Miyokard Perfüzyon Sintigrafisi ve Koroner Anjiografi Sonuçlarının Karşılaştırılması

Significancy of Myocardial Perfusion Scintigraphy

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Özet

Amaç: Koroner arter hastalığı (KAH) tüm dünyada en sık gö¬rülen mortalite ve morbidite sebeplerinden birisidir. Ko¬roner arterlerdeki anatomik darlığın kesin tanısında altın standart koroner anjiografidir. Miyokard Perfüzyon Sintigrafisi (MPS) ise KAH tanısında kullanılan non-invaziv görüntüleme yöntemlerinden biridir. Çalışmamızda MPS ile koroner anjiografi bulgularının karşılaştırılması amaçlandı. Gereç ve Yöntem: Çalışmaya anjina nedeni ile MPS yapılmış ve pefüzyon defekti saptanmış 81 hasta (37 erkek, 44 kadın; yaş ortalaması: 55 ± 10.95 yıl) dahil edildi. Hastaların tamamına koroner anjiografi yapıldı. Koroner anjiyografide ≥ % 50 darlık patolojik kabul edildi. Koroner anjiyografi ile MPS sonuçları karşılaştırıldı. Bulgular: 51 (% 63) hastada MPS ile koroner angiografi sonuçları uyumlu bulundu. Diğer hastaların 4'ünde (% 5) < % 50 koroner darlık saptandı. Hastaların kalan 26' sında (% 32) koroner anjiografi normal olarak bulundu ve bu hastalar mikrovasküler anjina olarak ta bilinen kardiyak sendrom X olarak değerlendirildi. Tartışma: Bulgular, mikrovasküler düzeydeki miyokard perfüzyon bozukluklarının erken tanısında MPS'nin koroner anjiografiye üstün olduğunu gösterdi. Dolayısıyla, koronerlerde anatomik olarak büyük darlık oluşmadan tedaviye başlayabilmek için MPS' nin öncelikli tanı aracı olması gerektiği kanısına varıldı.

Anahtar Kelimeler

Koroner Arter Hastalığı; Miyokard Perfüzyon Sintigrafisi; Koroner Anjiografi

Abstract

Aim: Coronary artery disease (CAD) is one of the most frequent causes of mortality and morbidity worldwide. Coronary angiography is the gold standard for the anatomical diagnosis of coronary artery stenosis. Myocardial Perfusion Scintigraphy (MPS) is a non-invasive imaging modality used for the diagnosis of CAD. In this study, we aimed to compare the findings of MPS and coronary angiogram. Material and Method: Eighty-one patients (37 males, 44 females; mean age 55 ± 10.95 years) with angina and detected perfusion defects on MPS were included in this study. All of the patients underwent coronary angiogram. A narrowing ≥ 50% was considered pathological on the coronary angiography. Results: Findings of the coronary angiogram and MPS were compared and found consistent in 51 (63%) patients. A coronary narrowing < 50% was detected by coronary angiogram in 4 (5%) of the remaining patients. Coronary angiogram was found to be normal in the remaining 26 patients (32%) and these patients were evaluated as cardiac syndrome X (CSX) known as microvascular angina (MA). Discussion: The findings showed that MPS is superior to coronary angiogram in the early diagnosis of myocardial perfusion disorders at the microvascular level. Therefore, we concluded that MPS should be the primary diagnostic tool to begin treatment before an anatomically large narrowing occurs in the coronaries.

Keywords

Coronary Artery Disease; Myocardial Perfusion Imaging; Coronary Angiography

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Introduction

Coronary artery disease (CAD) is a leading cause of morbidity and mortality and accounts for a large share of health costs worldwide. Therefore, diagnosis of CAD before surgery or coronary angiographic intervention is gaining importance to begin preventive treatments and to guide further management. Invasive coronary angiography is a traditional diagnosis modality and the gold standard to indicate coronary artery anatomy. However, it remains insufficient to evaluate the microvascular pathology cardiac syndrome X (CSX) or the functional status of a coronary stenos to predict the functional recovery following revascularization [1]. In this regard, image modalities reflecting microvascular pathology before overt clinical manifestations gain more significance.

Angina appears because of increased oxygen consumption with left ventricular hypertrophy, tachycardia, hypertension or decreased oxygen delivery via anemia, decreased blood flow due to stenosis or vasospasm [2].The ischemic changes starts in the subendocardium and moves toward the epicardium; this can be shown in the delayed enhancement sequences by MRI. Functional assessment of myocard and ischemia can be evaluated by demonstrating perfusion or wall motion abnormalities on cardiac MRI (CMR) including stress CMR and delayed enhancement sequences (stress MRI), stress echocardiography (SE), myocardial perfusion scintigraphy (MPS) with single photon emission CT (SPECT), and positron emission tomography (PET) imaging via adenosine, dipyridamole, exercise, or dobutamine [3]. Thus, ischemia which is not present on the nonstress images can be diagnosed with the post-stress images.The stenotic vessel which is already maximally dilated at rest to maintain myocardial oxygenation is not able to respond to stimulation of vasodilatation due to the loss of it's vasodilatory reserve. Adenosine and dipyridamole are used as vasodilatoryagents while exercise and dobutamine are used as ionotropic stress agents with imaging modalities to detect perfusion abnormalities.

The commonly used radio-isotopes are thallium-201, Tc-99m sestamibi and Tc-99m tetrofosmin in SPECT. Ischemia is suspected when there is a reduced tracer uptake on the stress acquisition which is reversible on the rest acquisition. Having a defect on both stress and rest acquisitions is suggestive of an infarct when possible attenuation artifacts are exluded [4]. In this study, we aimed to comparethe findings of MPS and coronary angiography in patients with detected myocard perfusion defect and reviewed the value of two tools in the early diagnosis of myocard perfusion defect.

Material and Method

The subjects were selected from patients who had presented to Gaziantep University Nuclear Medicine Department due to chest pain, an abnormal exercise ECG or a failed exercise ECG test between June 2010 and April 2011. Among these subjects, 81 patients (38 male, 44 female, mean age: 55 ± 10.95 years) with ischemia and/or infarct identified with MPS were included in the study. All patients underwent coronary angiography within one month. The patients were informed about the procedure and the radiopharmaceuticals to be administered. This study was approved by the independent ethics committee of the university and aligned with the ethical principles of the Declaration of Helsinki. MPS protocol was applied in the subjects using the SPECT method. Vasodilator-effective drugs were stopped at least 48 hours before investigation. Stress images were acquired at the first day through a treadmill and rest images were acquired on the second day. Intravenous 20 mCi Tc 99m-MIBI was injected in every operation. Low energy high resolution (LEHR) collimator was used in the imaging. After monitoring the patients, the exercise test was implemented with a treadmill using Bruce protocol. The targeted maximal pulse value was calculated according to "210-age" formula. Reaching 85% of the target pulse, collapse of ST segment >2mm, over elevation in blood pressure (systolic>250 mmHg, diastolic >120 mmHg), hypotension, and observation of extreme weakness, shortness of breath and ventricular arrhythmia were accepted as criteria for the termination of the exercise test. Images acquired were evaluated by 3 nuclear medicine specialists with gray scale and colored scale at different times. Detection ofmyocardial perfusion defectswas accepted as a lesion. Perfusion defects were divided into 2 categories reversibledefect (myocardial ischemia) and irreversible defect (severe ischemia/scar tissue).

Coronary angiography was performed in the catheter laboratory of Gaziantep University, Cardiology Clinic. In all patients images were acquired at LAO (left anterior oblique) 45-60° and RAO (right antero-oblique) positions for the left coronary artery and, RAO 30° straight, 30-15° cranial, 30-15° caudal and LAO 45-60° straight, 15° cranial, 15° caudal and also at left lateral, posteroanterior and 20° caudal positions for the left coronary artery. About 6-8 mL of enhancement agent was manually injected during each acquisiton. Coronary angiography was performed by a single operator using similar catheterization equipment. Quantitative coronary analysis was carried out using diameter of the diagnostic catheter for calibration of the magnified image. Vessel diameter, minimal lumen diameter and stenosis diameter percentage were measured using an automated analytic system. The lesions of50% or higher were considered as serious coronary stenosis. Cine images were assessed by an experienced cardiologist.

Results

The mean age of patients was 55 ± 10.95 (range: 41-82). In the assessment of obesity according to BMI, 33(40.7%) patients were obese, 30 (37%) were overweight, and 18 (22.3%) patients were normal weight. Among all patients 2 (2.4%) had an implanted stent and 5 (6.1%) had history of a by-pass operation. Sixty-three (77.7%) cases had hypertension and 42(51.8%) patients were smokers. Twenty-seven (22.2%) patients had a first-degree relative with a history of coronary heart disease. In addition, 48 (59.2%) patients had hyperlipidemia, 30 (37%) patients had diabetes mellitus (DM) and 4 (4.9%) patients have had left bundle branch block. According to history and ECG findings, 13 (22.3) patients were found to have previous myocardial infarction.

Single or multiple artery narrowing of more than 50% according to coronary angiogram was detected in 51 of 81 patients who had pathological findings on myocardial perfusion scintigraphy. Of these 51 patients, 26 (50.9%) patients had a single vessel coronary artery lesion, 17 (33.3%) patients had two vessel lesions, and 5 (15.6%) patients had three vessel lesions. Although

only 4 of the remaining 30 patients had narrowing between 30% and 50% in coronary arteries on coronary angiogram, ischemia was found in the regions fed by these vessels on MPS. Of these patients 3 had narrowing in the LAD (35% in 2 cases, 40% in 1 case) and the remaining 1 patient had narrowing in the RCA (40%).There were no soft tissue artifacts on MPS raw images, and the reduction in perfusion occurring in the areas supplied by the vessels with insignificant stenosis was accepted as real ischemia.

Twenty –six of 30 (86.6%) of patients who were detected by MPS as having ischeamia despite normal coronary angiogram finding were identified as microvascular pathology (cardiac syndrome X) according to criteria of typical angina, stress test positivity, normal angiogram, positive MPS results, and a history of obesity, hyperlipidemia, DM, or hypertension. Twelve (46.1%), 14 (53.8), 10 (38.3%) and 16 (61.1%) of these patients had a history of obesity, hyperlipidemia, DM, or hypertension (parameters of metabolic syndrome), respectively.

Discussion

Guidelines recommend the stress electrocardiography (ECG) test as the first-line of investigation inischemic coronary pathology [5]. Stress echocardiography is mostly useful in the case of contraindicated stress ECG. A SPECT is recommended for the diagnosis of CAD in the following conditions: (i) contraindications to performing stress ECG, (ii) inability to perform stress ECG, (iii) suspicious stress ECG, (iv) abnormal resting ECG.The sensitivity and specificity of SPECT for the diagnosis ofsignificant coronary stenosis (defined as >50% stenosis) are about 86% and 74%, respectively [6]. A false negative result may be seen in the case of three-vessel and left main stem stenosis, because SPECT assesses relative perfusion defects. A study evaluating the accuracy of SPECT on 101 patients who underwent coronary angiograph showed that 13–15% of patients with left main stem stenosis had a normal perfusion with SPECT [7]. Otherwise, attenuation artifacts, for example an elevated diaphragm or breast artifact, may cause a false positive result lowering the specificity [8]. Even than, SPECT is still a valuable tool for predicting cardiovascular events (CVE) indicating a pathology on the microvasculary level. A study performed in patients with stable chest pain syndromes showed that normal stress SPECT images reflect a very low risk of death or nonfatal myocardial infarction (MI) and coronary revascularization can not improve survival in such patients. Otherwise, patients with abnormal images with SPECT had an intermediate to high risk for future cardiac events for about 6.7–7% , annually [9]. Because of the upward trend of annual risk in patients who have high risk factors related to age and sex, stress-induced ECG changes and diabetes mellitus, SPECT should be especially repeated even in the patients with normal stress SPECT so as not to miss syndrome X [4].

Cardiac syndrome X (CSX), also known as microvascular angina (MA), is included among stable coronary syndromes. Gabriele Fragasso et al. showed that patients with CSX and detected inducible myocardial hypoperfusion at MPS had a more severe prognosis with more hospitalizations and symptomatic burden for CAD [10]. Patients with CSX have an annual riskof 2.5% of adverse episodes such as sudden cardiac death, myocardial infarction, stroke, and congestive heart failure [11]. In 1988, Cannon at al. first showed an association between chest pain and electrocardiogram (ECG) changes with changes in microcirculation [12]. Although there is a discussion of whether CSX should be treated as a form of ischemic heart disease, some studies have reported that patients with CSX account for about 10–20% of all patients with symptoms of angina and it was seen that more than 50% of these patients had a persistence of chest pain not responding to short-acting nitrates after exercise [13-15]. Because of the exclusion of MAfrom other classic forms of ischemic main coronary vessels, no standard treatment approach exists. Medications for CAD and non-pharmacological interventions such as lifestyle changes, diet modification and increased physical activity can be applied in patients with suspected CSX.

Patients with MA exhibit only a partial perfusion defect related with a small artery supplying blood (a small muscule area), so it may not cause symptoms of transmural hypoperfusion. Moreover, even if a large area of cardiac muscle is affected, symptoms may not occur, because all the vessels in the area may not be affected. In this regard, although symptoms of ischemia can be masked, it may cause chest pain and ECG changes and it may be detected with a radionuclide test. Currently used methods of imaging in the diagnosis of MA are PET, cardiac MRIi and SPECT [16]. Wojciech Szot et al. conducted a study assessing the effect of cardiac rehabilitation (reducing overweight, regular exercise) on SPECT tests change in patients with MA. Accordingly, improvement in myocardial perfusion in SPECT tests, reduction in the frequency and severity of chest pain and better blood pressure control following cardiac rehabilitation were detected [17]. At rest, patients with MA have a normal or slightly reduced blood flow in vessels. However, it changes during physical exercise or with stress tests because it can not response to increased request. Impaired capacity for vascular relaxation due to low level of nitric oxide released from the endothelial cells of small blood vessels and increased release of vasomotor mediators (endothelin, norepinephrine, renin, angiotensin II, and vasopressin) act in this pathogenesis [18]. İmproving endotelial dysfunction with cardiac rehabilitation was clearly shown with changing SPECT images in that study.

Metabolic syndrome (MetS) is definedas the combination of diabetes mellitus, hypertension, dyslipidemia,central obesity, and microalbuminuria. It is an important risk factor for cardiovascular diseases [19,20]. Kenichi Nakajima et al evaluated the risk of cardiovascular

events of patients who had metabolic syndrome (MetS) without coronary artery disease symptoms (CAD). Accordingly, myocardial perfusion scintigraphy did not differ between patients with and without MetS [21]. This, could arise from including patients without any cardiac symptom in that study. Having symptoms of angina and having ECG changes increase the positivity of MPS. Otherwise, a high MPS defect score was related to cardiovascular events in this study, as mentioned above. In our study,we found normal range (<50 stenosis including 30-50 stenosis) coronary angiogram in 38.1% of patients with detected ischemia in MPS. MetS was recorded in 38.3% of this group. These results indicate the efficiency of MPS in detecting the ischeamia at the areas with smaller than 50% stenosis in coro-

nary vessels. Also, most of these patient were observed to have MetS. Patients who were accepted as normal due to stenosis below 50% in coronary angiogram, but exhibiting ischemia in MPS together with angina symptoms should be considered as high risk cases in terms of CSX. Both preventive medication and non-pharmacological life style changes should be proposed and MPS should be repeated especially in those patients having MetS.

Conclusion

In conclusion, our findings support the inadequacy of coronary angiogram without MPS in the diagnosis of coronary artery disease.

Competing interests

The authors declare that they have no competing interests.

References

1. Tonino PA, Fearon WF, De Bruyne B, Oldroyd KG, Leesar MA, Ver Lee PN, et al. Angiographic versus functional severity of coronary artery stenoses in the FAME study fractional flowreserveversus angiography in multivessel evaluation. J Am Coll Cardiol 2010;55:2816-21.
2. Crossman DC. The pathophysiology of myocardial ischaemia. Heart 2004;90:576–80.
3. Pakkal M, Raj V, McCann GP. Non-invasive imaging in coronary artery disease including anatomical and functional evaluation of ischaemia and viability assessment. Br J Radiol 2011;84(3):280-95.
4. Hachamovitch R, Hayes S, Friedman JD, Cohen I, Shaw LJ, Germano G, et al. Determinants of risk and its temporal variation in patients with normal stress myocardial perfusion scans: what is the warranty period of a normal scan?J Am Coll Cardiol 2003;41:1329-40.
5. Antman EM, Smith SC, Alpert JS, Gregoratos G, Anderson JL, Hiratzka LF, et al. with Task Force Members. ACC/AHA/ASNC Guidelines for the Clinical Use of Cardiac Radionuclide Imaging executive summary: a report ofthe American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASNC Committee to Revise the 1995 Guidelines for the Clinical Use of Cardiac Radionuclide Imaging). J AmColl Cardiol 2003;42:1318–33.
6.Underwood SR, Anagnostopoulos C, Cerqueira M, Ell PJ, Flint EJ, Harbinson M, et al. Myocardial perfusion scintigraphy: the evidence. Eur J Nucl Med Mol Imaging 2004;31:261–91.
7. Berman DS, Kang X, Slomka PJ, Gerlach J, de Yang L, Hayes SW, et al. Underestimation of extent of ischemia by gated SPECT myocardial perfusion imaging in patients with left main coronary artery disease. J Nucl Cardiol 2007;14:521-8.
8. Dondi M, Fagioli G, Salgarello M, Zoboli S, Nanni C, Cidda C. Myocardial SPECT: what do we gain from attenuation correction (and when)? Q J Nucl Med Mol Imaging 2004;48:181-7.
9. Iskander S, Iskandrian AE. Risk assessment using single-photon emission computed tomographic technetium-99m sestamibi imaging. J Am Coll Cardiol 1998;32:57-62.
10. Gabriele Fragasso, Ludovica Lauretta, Elena Busnardo, Michela Cera, Cosmo Godino, Antonio Colombo, et al. Prognostic role of stress/rest myocardial perfusion scintigraphy in
patients with cardiac syndrome x. Int J Cardiol 2014;173:467-71.
11. Reis SE, Holubkov R, Conrad Smith AJ, Kelsey SF, Sharaf BL, Reichek N, et al.; WISE Investigators. Coronary microvascular dysfunction is highly prevalent in women with chest pain in the absence of coronary artery disease: results from the NHLBI WISE study. Am Heart J 2001;14:735-41.
12. Cannon RO, Epstein SE. "Microvascular angina" as a cause of chest pain with angiographically normal coronary arteries. AmJ Cardiol 1988;61:1338–43.
13. Singh M, Singh S, Arora R, Khosla S. Cardiac syndrome X: current concepts. Int J Cardiol 2010;142:113–9.
14. Kaski JC, Elliot PM. Angina pectoris and normal coronary arteriograms: clinical presentation and hemodynamic characteristics. Am J Cardiol 1995;76:35–42.
15. Herrmann J, Kaski JC, Lerman A. Coronary microvascular dysfunction in the clinical setting:from mystery to reality. Eur Heart J 2012;33:2771-82.
16. Johnson BD, Shaw LJ, Buchthal SD, Bairey Merz CN, Kim HW, Scott KN, et al. National Institutes of Health-National Heart, Lung, and Blood Institute. Prognosis in women with myocardial ischemia in the absence of obstructive coronary disease: results from the National Institutes of Health-National Heart, Lung, and Blood Institute-Sponsored Women's Ischemia Syndrome Evaluation (WISE). Circulation 2004;109:2993-9.
17. Szot W, Zając J, Kubinyi A, Kostkiewicz M. The effects of cardiac rehabilitation on overall physical capacity and myocardial perfusion in women with microvascular angina. Kardiol Pol 2016;74:431-8.
18. Wu EB. Microvascular dysfunction in patients with cardiacsyndrome X. Heart 2009;95:521.
19. Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Report of a WHO Consultation. Part 1: Diagnosisand Classification of Diabetes Mellitus. World Health Organization Department of Noncommunicable Disease Surveillance, Geneva, 1999.
20. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive summary of the thirdreport of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of HighBlood Cholesterol in Adults (Adult Treatment Panel III). JAMA 2001;285:2486-97.
21. Nakajima K, Takeishi Y, Matsuo S, Yamasaki Y, Nishimura T. Metabolic syndrome is not a predictor for cardiovascular events in Japanese patients with diabetes mellitus asymptomatic for coronary artery disease: a retrospective analysis of the J-ACCESS-2 study. J Nucl Cardiol 2013;20:234-41.

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